Vaporizer Classification

A. Method of regulating output concentration
   1. Concentration calibrated (variable-bypass)
   2. Measured flow (copper Kettle)

B. Method of vaporization
   1. Flow over
   2. Bubble Through
   3. Injection

C. Temperature compensation
   1. Thermocompensation
   2. Supplied heat

D. Specificity
   1. Agent specific
   2. Multiple agent

E. Resistance
   1. Plenum
   2. Low resistance

Basic Concentration calibrated, flow over, thermocompensation, agent specific, plenum vaporizer

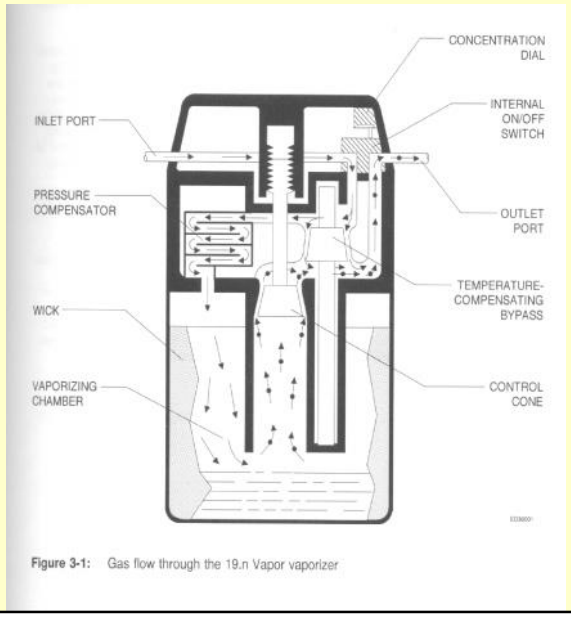

Figure 3-1: Gas flow through the 19.n Vapor vaporizer

Method of regulating output concentration

Concentration Calibrated (Variable Bypass)

- Total carrier gas flow automatically divided into two paths, One path flowing through vapor above liquid anesthetic. The other bypassing the vapor chamber. The two flows meet and mix at the outflow tract. The concentration of the anesthetic determined by the flow ratio

Examples are:
Tec 3, 4, and 5 Vaporizers- Most common

Tec 6 Vaporizer- Desflurane use only

Method of regulating output concentration

Measured Flow (Copper Kettle)

- Also known as bubble through or Vernitrol.
- Flow meter-measured. Manually calculated bypassed carrier flow.
- Temperature compensated by construction materials with high specific heat and thermal conductivity to off set cooling from vaporization induced heat loss. ie. copper

Method of vaporization

Flow Over

- Carrier gas flows OVER liquid picking up vapor.
- Efficiency improved by increasing area that carrier gas flows over gas-liquid interface. ie. Baffles or wicks

Method of vaporization

Bubble Through

- Carrier gas is broken into small bubbles usually by a mesh screen and bubbled through the liquid anesthetic.

Method of vaporization

Injection

- Liquid anesthetic or pure vapor is injected into volume of gas.
- If both the volume of carrier gas and anesthetic volume is known control of vapor concentration can be calculated.

Temperature compensation

Thermocompensation

- Vaporization causes energy (heat) to be lost.
- Decreased temperature decreases vapor pressure.
- To prevent fluctuations in vaporizer output owing to temperature changes compensatory mechanisms are built in
- Use of a valve that changes flow through vaporizer based on temperature.

Temperature compensation

Supplied Heat

- Maintains a constant temperature by electric heater.
- Example Tec 6 Desflurane vaporizer

*Desflurane specific vaporizer
* Low boiling point 22.8C causes unpredictable output
*Warms liquid Desflurane to 1,500 mmHg
*Controls gas output by variable resistance controlled by a differential pressure transducer
*Must be connected to electrical outlet

Specificity

Agent Specific

- Calibrated and constructed for use with only one specific anesthetic agent.
- Must be labeled which anesthetic contained within.
- Use of other agents may give incorrect concentration and may damage vaporizer or cause harmful byproducts.
- Question; If Halothane was inadvertently put into an Ethrane vaporizer would the anesthetic concentration be equal to, less than, or greater the dialed desired concentration?

Specificity

Multiple Agent

- Rarely in use and not advised.
- May be used with multiple agents
- Must be labeled with agent agent contained within.

Resistance

Plenum

- The vaporizer chamber pressure exceeds the pressure outside.
- Dependant on compressed gasses driven under pressure through vaporization chamber or liquid anesthetic.
- Most modern vaporizers are Plenum type

Resistance

Low Resistance

- Low resistance and allow placing within the breathing system.
- Vaporization accomplished by ventilatory gas flows.

Ideal Gas Law

Gasses behave predictably and is expressed by the Ideal Gas Law.

IDEAL GAS LAW

PV=nrT

P= Pressure
V= Volume
n= number of moles of gas
r= ideal gas law constant
T= Temperature

Vaporization Terms

*Vapor Pressure- Pressure exerted on walls of a container by molecules that broke away from the liquid surface. Equilibrium will be achieved if temperature remains constant. All volatile anesthetics posses a specific vapor pressure. From this vapor pressure above the liquid the concentration can be calculated.

*Boiling Point of liquid- The temperature at which the vapor pressure is equal to atmospheric pressure.

*Heat of Vaporization- The number of calories needed to convert 1 Gm of liquid into a vapor. (1ml of liquid may also be used to express heat of vaporization)

*Specific Heat- The quantity of heat required to raise the temperature of 1 Gm of the substance 1C. (1ml of substance may also be used to express specific heat)

Concentration of Gasses:

*Partial pressure- The pressure exerted by a gas in a mixture is proportional to its percent of that mixture. The total pressure exerted by a mixture of gasses is the sum of all its component partial pressures.

*Volumes Percent(Vol. %)- The number of units of volume of gas in relation to a total of 100 units of volume for the total gas volume.

Inhalation of foreign substances

Causes include:
- *Absorbent dust
- *Residual ethylene oxide or glycol
- *Contaminants in compressed air
- *Breathing system components, and foreign bodies

Preventing or detecting foreign substances:
- *Assessment of patient and machine during set up and use
- *Airway obstruction will cause high airway pressure alarms to *sound
- *Use of filter on breathing Circuit
- *Never release bag pressure at Y-connect-use APL valve

Overdosing

Overdose causes:
- *Tipping of vaporizer
- *Vaporizer inadvertently turned on or never turned off from previous use
- *Overfilled vaporizer
- *Simultaneous use of vaporizers (pleural) on older machines without interlock system
- *Incorrect calculations with measured-flow vaporizers
- *N_2O flowmeter bobbin or float stuck at top of Thorpe tube
- *Pumping effect due to inspiratory positive pressure from manual or assisted ventilation or use of O2 flush valve transmitted back to vaporizer. Seen with low flows.

Inadequate dose

Inadequate dose causes:

Light anesthesia is not always as serious, but may be deleterious

*O_2 flowmeter bobbin or float stuck at top of Thorpe tube
*Disconnect that allows air to be entrained into breathing system
*Repeatedly using flush valve diluting concentration
*Leak in bellows
*Empty or leak in vaporizer
*Incorrect calculations with measured-flow vaporizers
*Pressurizing effect- due to inspiratory positive pressure from manual or assisted ventilation or use of O2 flush valve transmitted back to vaporizer.

Seen with high flows.